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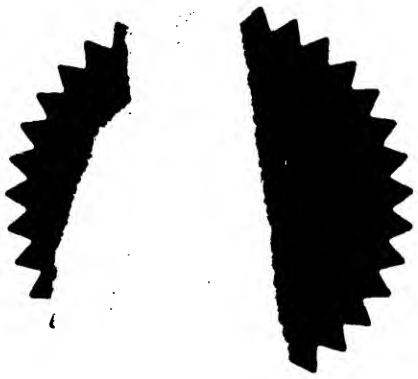

Signed

Dated 28 August 2003

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02 OCT 2002

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1/77

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P01/7700 0.00-0222829.4

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference — **P/2035.GB/MWM**

2. Patent application number
(The Patent Office will fill in this part) — 0222829.4

3. Full name, address and postcode of the applicant or of each applicant *(underline all surnames)*

Tektronix International Sales GmbH
Vordegasse 3
CH-8201 Schaffhausen
Switzerland

Patents ADP number *(if you know it)* — 84630510001

If the applicant is a corporate body, give the country/state of its incorporation — **Switzerland**

4. Title of the invention — **COLD BOOT TIMING**

5. Name of your agent *(if you have one)* — **Wildman, Harrold, Allen & Dixon**

"Address for service" in the United Kingdom to which all correspondence should be sent

(including the postcode)

11th Floor, Tower 3,
Clements Inn,
London,
WC2A 2AZ
United Kingdom

Patents ADP number *(if you know it)* — **08187346001**

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* each application number

Country	Priority Application Number *(if you know it)*	Date of Filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body
See note (d)

Yes

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9. Enter the number of sheets for any of the following items you are filing with this form.
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Continuation sheets of this form	
Description	**8**
Claim*(s)*	**To Follow**
Abstract	**To Follow**
Drawings*(s)*	**3** 4 3

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	**1**
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Wildman Harrold Date **2 October 2002**
WILDMAN, HARROLD, ALLEN & DIXON

12. Name and daytime telephone number of person to contact in the United Kingdom — **Clifford J Want** — **020 7831 0009**

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Cold boot timing

This invention relates to determining cold boot timings for applications transmitted in a transport stream and, in particular, but not limited to, a Multimedia Home Platform stream.

Digital Video Broadcasting (DVB) transport streams may contain Object Carousels to make data files available to a DVB receiver. These data files typically contain either applications for running on the DVB receiver or data that is referenced by the applications. One or more Object Carousels may be carried within a DVB multiplexed transport stream in a same way as video and audio streams. The transport stream may contain one or more services and each of the services may contain one or more Object Carousels. The services may be identified by a Program Application Table (PAT), a Program Map Table (PMT) and Service Information (SI).

Each Object Carousel has a service gateway which is a root directory of a file system of assets delivered by the Object Carousel and must be acquired before any other object can be downloaded. Any asset belonging to the Object Carousel will appear in the service gateway, i.e. a root asset and remaining assets are contained in the Object Carousel. The root asset then must be downloaded followed by all remaining assets or objects. Where the application is a Java application, the root asset is a boot class. A manner in which assets may be identified from the service gateway is defined in the MPEG specification ISO/IEC 13818-6:1998: "Information technology -- Generic coding of moving pictures and associated audio information -- Part 6: Extensions for DSM-CC".

The way in which the hierarchical structure of the service gateway is transmitted will affect the order of acquisition of the assets. This means that assets will only be capable of being downloaded when the full path to the assets has been received. The assets are contained in modules in the transport stream.

It will be apparent that many sections containing modules have to be received, in a specific order, from the transport stream before a section containing the content required is located in the transport stream. A set-top box will not pay attention to modules received in the transport stream unless the set-top box knows the modules' content is of interest. The set-top box only knows a module containing an asset is of interest when the asset is identified in the service gateway. The set-top box would then

have to wait for the next instance of this module, starting at the time that the section identifying the asset was received.

Cold boot timing is known for enabling a user to observe how long it would take a receiver, such as a set-top box, to download, in order, from the transport stream all of the data associated with a given application, assuming that the receiver had just been switched on, and the receiver did not have any previously retained information. By repeating this calculation at intervals along the stream being analysed, the user can determine a series of different cold boot timings, dependant on when the set-top box is nominally switched on.

A Multimedia Home Platform (MHP) may be defined by a DVB standard for the transmission of enhanced and interactive applications for, for example, digital television. Such an open standard is European Telecommunications Standards Institute TS 101812 "Digital Video Broadcasting (DVB); Multimedia Home Platform (MHP) Specification" available from ETSI, 650 Route des Lucioles, F-06921 Sophia Antipolis Cedex – France. MHP applications may be transmitted in a transport stream as pre-compiled Java programs, with MHP receivers incorporating a Java virtual machine which is able to run the MHP applications by decoding relevant file objects transmitted in the transport stream. Alternatively, an application can be, for example, an HTML page or set of pages. However, for MHP applications the cold boot timing described above would be inaccurate. An Application Information Table (AIT) is transmitted with or within an Object Carousel carrying MHP applications. The AIT provides information to the DVB receiver decoder about the data services and a required activation state of each MHP application carried. Cold boot timings for MHP transport streams therefore have to include the time to download the AIT. The AIT contains a description of the root asset. Using the AIT, an MHP set-top box does not need to know anything about an application before it is transmitted. By reading the AIT the set-top box can obtain an application name, the Object Carousel the application is associated with, the root asset or boot class, and its activation state i.e. whether the application should be run immediately, should wait for a stimulus, or is to be removed. The AIT may also carry pre-fetch information, which enables modules that are related to the application to be identified. The set-top box may then store first instances of these modules which are received, until they are referred to, when the set-top box can interpret the stored modules, rather than waiting for the next transmission of an instance of the module. Thus, the pre-fetch information can indicate which modules are relevant

to an MHP application. The boot process will then acquire the modules in parallel with locating the assets via a hierarchical tree. It could be possible for all of the modules to be pre-fetched before the complete tree required by the application has been built. In general, this will significantly decrease the cold boot timing.

It is an object of the present invention at least to mitigate the aforesaid disadvantage in the prior art and in particular to obtain cold boot timings for MHP applications which more accurately reflect the time a set-top box, for example, would need before an application became available.

According to a first aspect of the invention, there is provided a method for monitoring a nominal time to boot an application from a Multimedia Home Platform (MHP) transport stream containing an Application Information Table (AIT), the method comprising the steps of: selecting a start position in the transport stream and recording the start time; identifying in the transport stream a service having an Object Carousel and an associated AIT; receiving a next instance in the transport stream of the associated AIT section for the application; analysing the AIT section to determine a root asset and all remaining assets required by the application; receiving in the transport stream a next instance of a module containing the root asset and subsequently instances of modules containing all remaining determined assets for the application respectively and recording the time of receipt of the last such module as a finish time; and determining the nominal cold boot time by subtracting the start time from the finish time.

Advantageously, the step of determining the nominal cold boot time includes outputting a signal representative of the determined nominal cold boot time to a user interface.

Conveniently, the step of determining the nominal cold boot time includes selecting a new start position in the transport stream to restart the method for the new start position to determine succeeding cold boot timings.

Preferably, the step of outputting the determined nominal cold boot time to a user interface includes graphically displaying successive cold boot timings.

Advantageously, the step of analysing the AIT section includes detecting incorrect or insufficient AIT information in the AIT section properly to download the application and outputting a warning signal.

Preferably, the step of detecting incorrect or insufficient AIT information includes detecting an inability to boot the application because of the incorrect or insufficient AIT information.

Advantageously, the step of determining the nominal cold boot time includes fine tuning the transport stream by adjusting an AIT repetition rate in the transport stream to vary the nominal cold boot time.

According to a second aspect of the invention, there is provided a monitor for monitoring a nominal time to boot an application from a Multimedia Home Platform (MHP) transport stream containing an Application Information Table (AIT), the monitor comprising: selection means for selecting a starting position in the transport stream; service identifying means for identifying in the transport stream a service having an Object Carousel and an associated AIT; module identifying means for successively identifying in the transport stream next instances of the associated AIT section of the application, of a root asset of the application and of other assets of the application; analysing means for downloading and analysing the AIT section to determine the root asset and all the other assets of the application and informing the module identifying means such that the module identifying means may identify instances of the other assets in the transport stream in an order in which they are received; and timing means for measuring a cold boot time between the start position in the transport stream and receipt of the last of the other assets of the application.

Preferably the monitor further includes output means for outputting a signal representative of the determined nominal cold boot time to a user interface.

Conveniently, the output means is adapted for graphically displaying successive cold boot timings.

Advantageously, the analysing means is adapted to detect incorrect or insufficient AIT information in the AIT section for proper downloading of the application and outputting a warning signal.

Preferably, the analysing means is adapted to detect an inability of the application to boot because of the incorrect or insufficient AIT information.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a graphical illustration of elements of a transport stream for which cold boot timings are obtained according to the prior art;

Figure 2 is a graph of cold boot time as ordinates and data stream time as abscissa for the transport stream of Figure 1;

Figure 3 is the graph of Figure 2 extended over a longer period of time;

Figure 4 is a graphical illustration of elements of a MHP transport stream for which cold boot timings are obtained according to the invention;

Figure 5 is a graph of cold boot time as ordinates and data stream time as abscissa for the MHP transport stream of Figure 4;

Figure 6 is a state transition diagram of the invention.

In the figures like reference numerals denote like parts or steps.

The elements of an application transmitted in a typical multi-service, multi-application transport stream 10 of the prior art are illustrated in Figure 1, in which instances of each of the elements or modules are cyclically transmitted, typically with different cycle frequencies, within the transport stream. The elements are shown for the purposes of illustration only as regularly spaced within the stream.

Cold boot timing allows a user to observe how long it would take a set-top box to load all of the data associated with a given application, from a transport stream, assuming that the set-top box had just been switched on, and did not have any previously retained information (i.e. a cold boot). Typically, this calculation is performed at intervals along the stream being analysed. This means a user can see a series of different scenarios, depending on when the set-top box is (theoretically) switched on. In practice, an Object Carousel is identified and one or more applications to be timed are selected from a current application list. As each application is selected, software of a monitor checks the availability of the associated root asset and other assets.

As shown in Figures 1 and 2, in the prior art all the assets are received in a predetermined order. Thus starting from a selected position 101 in the transport stream at which a receiver nominally seeks to start to download an application, the first instance of a service gateway 11 of the application is received by a monitor in a stream

time t_1. After receipt of the service gateway, the next instance of a root asset or boot class 12 is received in a further time t_2, since the boot class must be downloaded before any of the other assets. This is because this timing method assumes no signalling caching. This simulates a set-top box not knowing which Carousel Objects or assets the boot class uses until the set-top box has completely received and processed the boot class asset. The boot class 12 has assets A, B and C. If assets A and B are directories this implies that there is a precedence in the order in which instances 13,14,15 of the assets may be downloaded. The transport stream is received until after a further time t_3 the first instance 13 of asset A is received. The next instance 14 of asset B is received in a further time t_4 and the next instance 15 of asset C in the transport stream is received in a further time t_5. Since assets are transmitted in modules, the end of each cycle actually will be the end of the module containing the last asset. If assets A, B and C identified files, then there would be no interdependence. That is, the cold boot timing would attempt to locate the files simultaneously. Therefore there are implied rules of precedence, dependent on a way in which the hierarchical tree structure is transmitted.

One instance of each of the assets of the application having been received, the cold boot time T_{11} starting at the selected position in the transport stream is calculated as the sum of t_1, t_2, t_3, t_4 and t_5. The value T_{11} of the cold boot time may be plotted on a graph as shown in Figure 2. As shown in Figures 1 and 2, further values, for example T_{12} and T_{13}, of the cold boot time may be obtained by starting at different selected positions 102, 103 respectively in the transport stream. The user may define a 'sampling' frequency; that is intervals at which to start the nominal download and observe how long it would take to signal the Object Carousel and download the service gateway, the boot class and all of the assets. For example, in a 60 second stream, an interval of five seconds will sample the download, or cold boot, time twelve times.

As shown in Figure 3, a plot of cold boot time may thus be obtained for positions throughout the transport stream for monitoring the transport stream.

In contradistinction to the prior art method described above, in the method of the invention, the AIT is also received and data from the AIT is used to determine the effect of pre-fetching assets other than the boot class.

Thus, referring to Figures 4 and 5, in the method of the invention, starting at an equivalent selected position 101 in a MHP transport stream 40, after the Service Gateway 11 and first instance 41 of the AIT for the chosen application are received by

a monitor, the monitor is aware of an interest in the modules that convey the boot class and the assets A, B and C so that the time is calculated to download first the first instance 12 of the boot class and then the first instances 13, 45, 14 of the other assets in an order in which there are received. It is apparent that in general this will result in a shorter cold boot time T_{41} than the cold boot time T_{11} measured in the prior art, and that the invention allows such cold boot time monitoring for MHP applications more accurately to reflect the amount of time a set-top box would need before the application becomes available, using the pre-fetch facility of the AIT of an MHP transport stream.

Referring to Figure 6, the method may be illustrated by a state diagram, in which a position is selected, step 61, in the transport stream at which the cold boot time is to be calculated and a timing cycle started. Packets of the transport stream are read, step 62, until a Service, identified by a Program Application Table (PAT), a Program Map Table (PMT) and Service Information (SI) is received, step 621. Succeeding packets of the transport stream are read, step 63, until an AIT of the predetermined application is received, step 631. The AIT is analysed to determine the root asset necessary to the application. Succeeding packets of the transport stream are read, step 64, until the root asset, or, in the case of a Java application boot class, for the predetermined application is received, step 641. Succeeding packets of the transport stream are read, step 65, until all the remaining assets of the predetermined application have been received, step 651 in an order in which next instances of each asset occur in the transport stream. The cycle time for a cold boot start is calculated from the start time and the time to receive the last of the assets of the application. The procedure is restarted, step 67, for a new position in the transport stream.

Thus the invention allows the AIT information to be analysed, and related to the applications in the stream. A connection is made between the application and the AIT that signals its presence.

In addition, the procedure may draw the user's attention to any errors in the stream. If the AIT information in the stream has not been generated correctly, the cold boot timing will be severely affected. It may even be apparent that the set-top box would be incapable of cold booting, due to the omission of correct AIT information. For example, an asset may be expected by an application but not be present in the service gateway. Alternatively, an asset may be identified in the service gateway but

not be transmitted in any module in the transport stream. In both cases a failure will be indicated in the cold boot process.

The procedure may also enable the user to analyse a relationship between the AIT and a particular application. The frequency with which the AIT is repeated in the stream can severely affect the cold boot time. The user can use the cold boot timing information to fine tune a test stream to improve the cold boot time for the particular application.

Although the invention has been described in relation to MHP transport streams containing AIT tables for determining cold boot timings, it will be appreciated that the invention has applicability to any transport stream containing a module identifying all other modules relevant to, for example, an application, program or service, and to the calculation of other boot or download timings than cold boot timings.

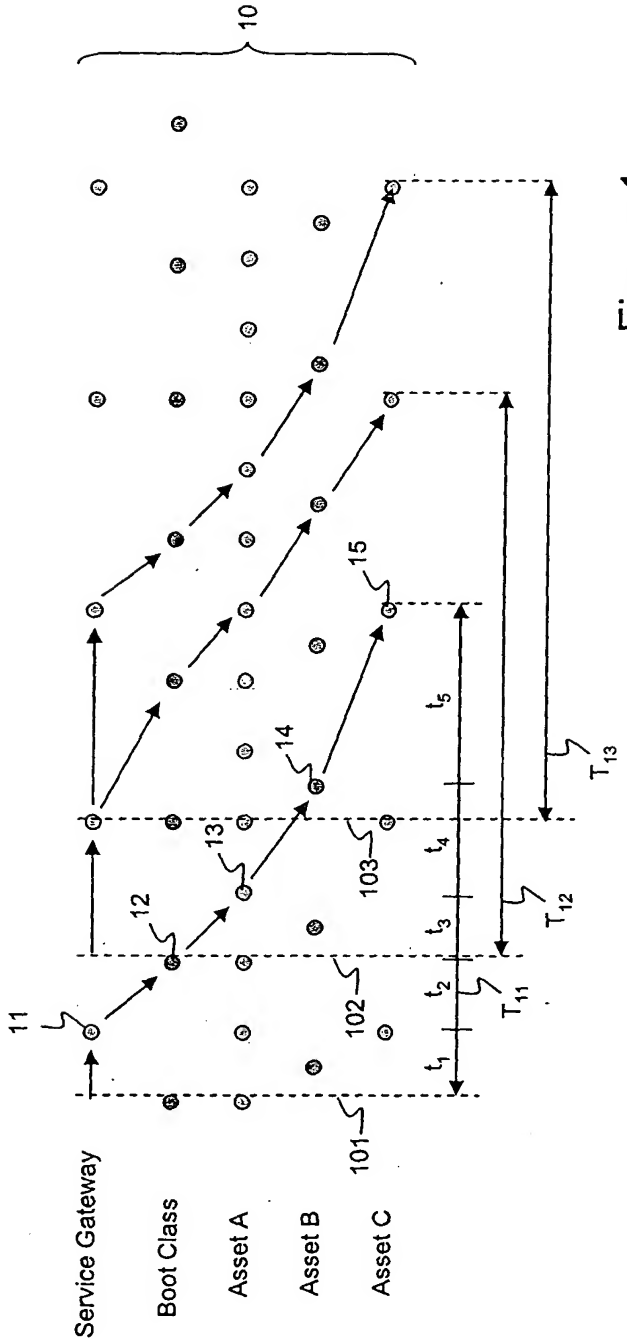

Figure 1
PRIOR ART

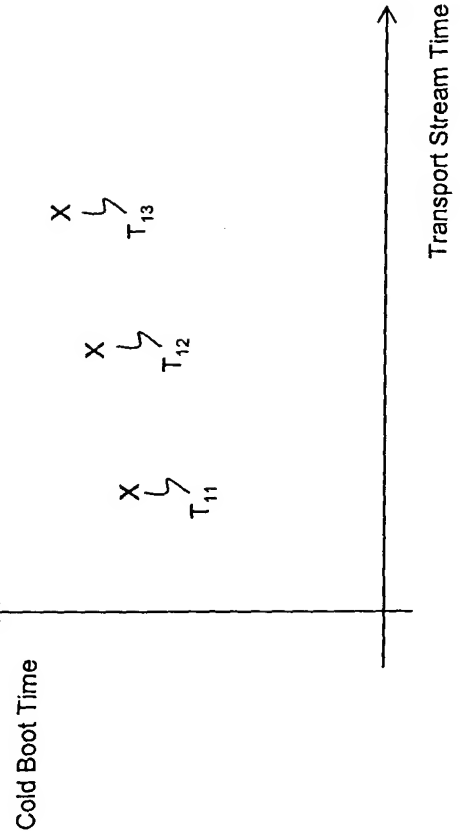

Figure 2
PRIOR ART

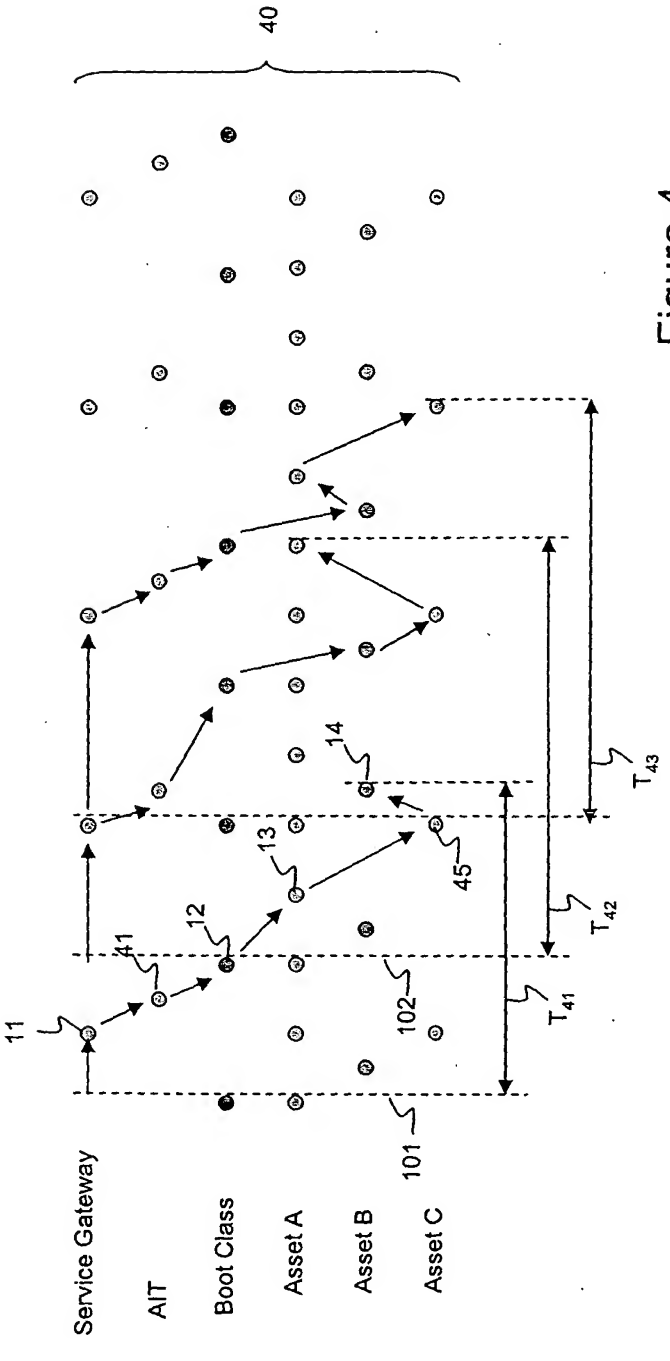

Figure 4

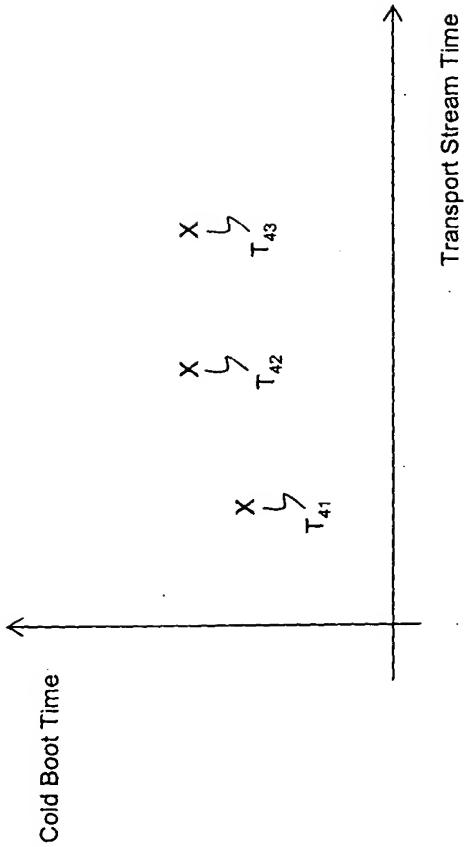

Figure 5

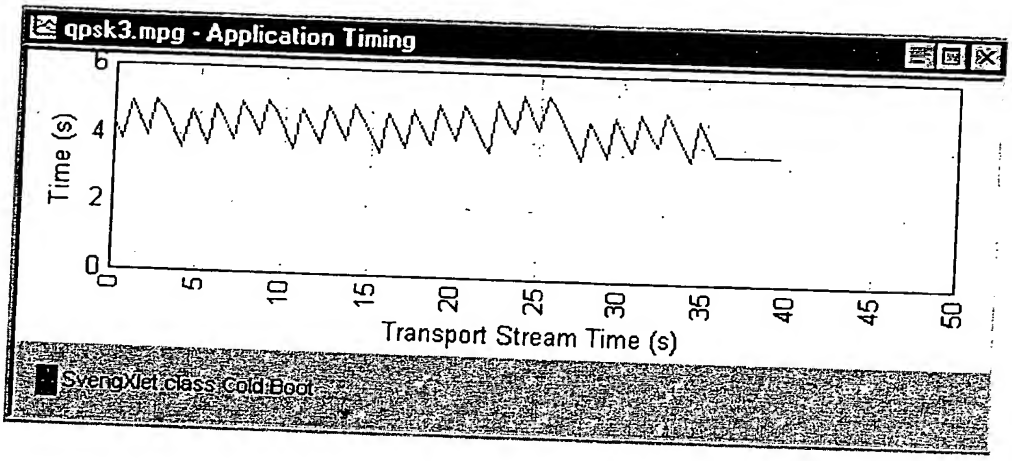
qpsk3.mpg - Application Timing
Time (s)
0
2
4
6
0
5
10
15
20
25
30
35
40
45
50
Transport Stream Time (s)
SvenoXlet.class.ColdBoot

Fig. 3

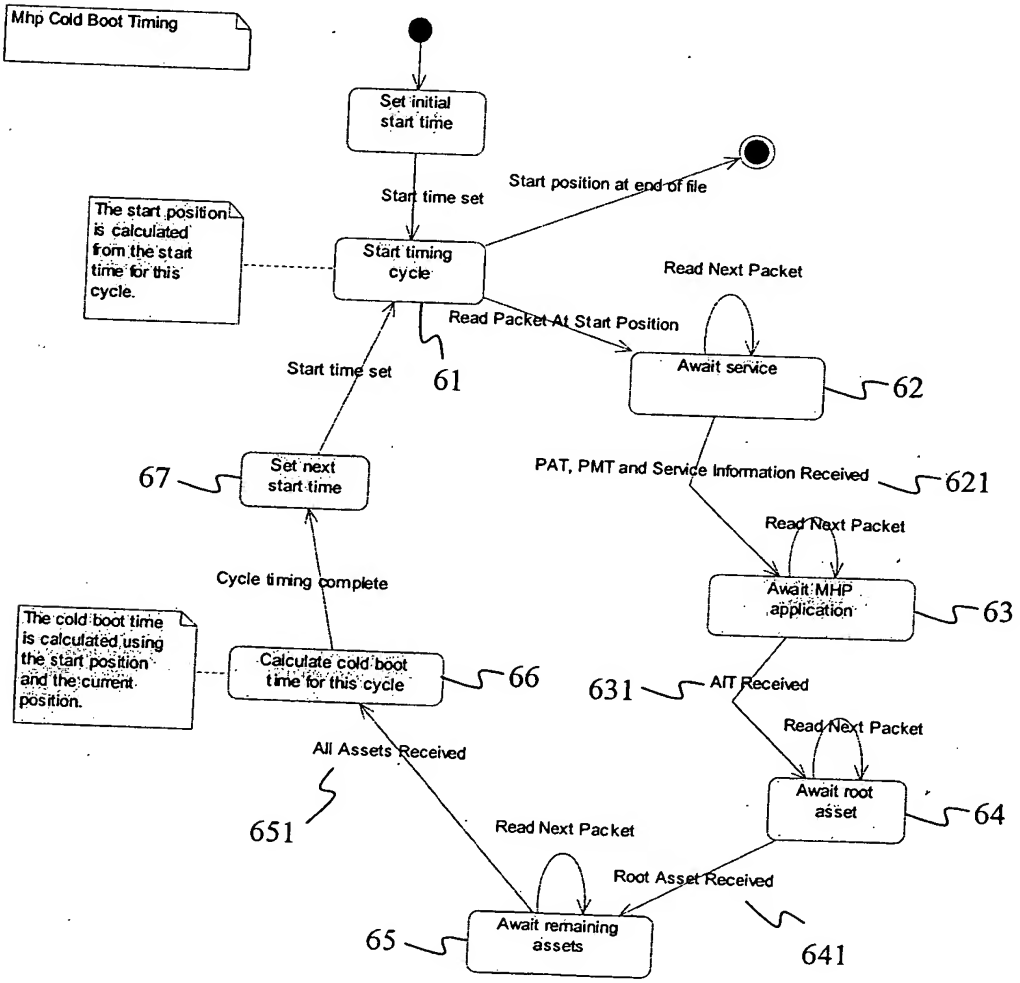
Mhp Cold Boot Timing
Set initial start time
Start time set
Start position at end of file
The start position is calculated from the start time for this cycle.
Start timing cycle
Read Next Packet
Read Packet At Start Position
Start time set
61
Await service
62
67
Set next start time
PAT, PMT and Service Information Received
621
Read Next Packet
Cycle timing complete
Await MHP application
63
The cold boot time is calculated using the start position and the current position.
Calculate cold boot time for this cycle
66
631
AIT Received
Read Next Packet
All Assets Received
651
Await root asset
64
Read Next Packet
Root Asset Received
65
Await remaining assets
641

Fig. 6